

WE CLAIM:

1. A hard, wear resistant article of manufacture comprising a cemented carbide substrate, substantially free of eta-phase, comprising tungsten carbide and 2-30 weight %  
5 binder selected from the group consisting of Co, Ni, Fe, and combinations thereof, wherein binder concentration increases from approximately zero at the substrate surface to nominal at a selected distance interior to the surface and does not exceed nominal.

2. The article of manufacture of claim 1 wherein said cemented carbide body  
10 further comprises at least one carbide of a metal of Groups IVA, VA, or VIA.

3. The article of manufacture of claim 1 wherein the selected distance interior to the surface ranges from 25 to 500 microns.

15 4. The article of manufacture of claim 1 wherein said binder is at least 3 weight % cobalt.

5. The article of manufacture of claim 1 wherein said article has porosity of less than 0.5 volume %.

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6. The article of manufacture of claim 1 wherein binder concentration increases according to a gradient of substantially constant slope extending from the surface to the interior of the substrate.

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5 7. An article of manufacture comprising an eta-phase-free cemented carbide body, composed of well-defined metal carbide grains and a binder wherein said binder concentration varies within the part according to a binder concentration gradient decreasing from nominal concentrations in the interior of the part to less than 1% at the part surface.

10 8. The article of manufacture of claim 7 wherein binder concentration decreases according to a gradient of substantially constant slope extending from nominal concentrations at a selected distance into the interior of the part to said substrate surface.

9. The article of manufacture of claim 7 wherein the selected distance interior to  
15 the surface ranges from 25 to 500 microns.

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10. A method of making a hard, wear resistant article comprising the steps of:

a) heat treating a green or pre-sintered article to produce a fully sintered product;

b) removing binder from surface regions of a cemented carbide article to a

20 selected depth within said article by immersion in a chemical etching solution;

c) heating the etched article in a vacuum between 1225 and 1275°C; and

d) further heating the article in a carburizing atmosphere between 1300 and

1350°C for a time sufficient to diffuse binder from interior regions of the article into said surface regions.

11. The method of claim 10 wherein said binder is removed to depths of  
5 approximately 20 - 60 microns.

12. The method of claim 10 wherein diffusing binder from the interior regions into said surface regions creates a decreasing binder concentration gradient from the interior regions to the surface regions.  
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13. The method of claim 12 wherein said relationship between depth of etch and depth at which nominal is reached has a substantially constant slope.

14. The method of claim 10 wherein said atmosphere has a partial pressure of  
15 carbon monoxide.

15. The method of claim 10 wherein said chemical etching solution comprises ferric chloride.

20 16. A method of making a hard wear resistant article comprising the steps of:  
a) removing binder from surface regions of a cemented carbide article to a selected depth within said article;

- b) heating the article in a vacuum to between 1200 and 1250°C; and
- c) introducing an atmosphere comprising carbon monoxide and further heating the article to between 1300 and 1350°C and holding at that temperature in the carbon monoxide atmosphere for a period of time sufficient to diffuse binder from interior regions of the article into said surface regions.

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